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REDESCRIPTION, RELATIONSHIPS AND STATUS OF THE MARYLAND DARTER, *ETHEOSTOMA SELLARE* (RADCLIFFE AND WELSH), AN ENDANGERED SPECIES

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Introduction

The original description of the Maryland darter, *Etheostoma sellare* (Radcliffe and Welsh, 1913), was based on two subadult male specimens taken in 1912. Little else has ever been published about this darter. Since 1961, seven collections have yielded 78 additional specimens. The purpose of this paper is to utilize the 80 existing specimens in a redescription of *E. sellare* and to summarize information concerning its biology and status as an endangered species.

Radcliffe and Welsh recorded the type-locality of the Maryland darter as "Swan Creek near Havre de Grace, Md." Presumably this is the Swan Creek actually located at Aberdeen and for 50 years many collections were taken in this and other streams in an effort to obtain Maryland darters. All attempts failed until 1962 when a group of Cornell University students discovered a juvenile specimen concealed among numerous juvenile tessellated darters that they had taken from Gasheys Run near Aberdeen, Maryland (Fig. 1). The rediscovery of the Maryland darter, reported by Knapp et al. (1963), stimulated field work along the lower Susquehanna River and an adult female was also taken in Gasheys Run by Knapp and party in April, 1965. As both Gasheys Run and

Fig. 1. Map of a portion of the Chesapeake Bay drainage in northern Maryland and southern Pennsylvania showing collection sites of *Etheostoma sellare*.

the adjacent Swan Creek are quite small, the question remained as to why rather substantial collecting efforts failed to take more specimens. This may have been answered when Edward C. Raney and Frank J. Schwartz located a population of the Maryland darter in Deer Creek near Havre de Grace in May, 1965. Although, collections had been taken from Deer Creek prior to 1965, the apparently restricted habitat of the darter near the creek mouth had been overlooked.

In recognition of its scarcity, the Maryland darter was designated as an endangered species in both the IUCN Red Data Book (Miller, 1969) and the U.S. Department of Interior Red Book of Threatened Wildlife of the United States (Bureau of Sport Fisheries and Wildlife, 1973). It also has been accorded similar status by Miller (1972) and by the Smithsonian Institution Center for Natural Areas (1974). Recently, the Maryland darter acquired a controversial aspect when a sewage treatment plant, built at Stewartstown, Pennsylvania, applied to the Environmental Protection Agency (EPA) for permission to release chlorinated wastes into Ebaugh's Creek, a headwater branch of Deer Creek. A public hearing was held

by EPA on 25 September 1974, and despite considerable opposition, the permit was granted effective 30 October 1974. If, as it appears likely, Deer Creek is the principal habitat of the Maryland darter, the darter may be placed in considerable jeopardy. A warning concerning possible detrimental effects of the chlorinated wastes on the darter was given by Knapp (1974).

Methods

The diagonal scale count is the number of scales downward and posteriorly from the origin of the second dorsal fin to, but not including the pored scales in the lateral sensory series. Cephalic sensory canal data was primarily taken from the right side of the head. The remaining counts and measurements used in this study follow the methods of Hubbs and Lagler (1958:19–24). Standard length (SL) and other measurements are given in millimeters (mm).

Etheostoma sellare (Radcliffe and Welsh)
Maryland darter

Hadropterus sellaris Radcliffe and Welsh, 1913:29–32 (original description, type-locality, Swan Creek).

Poecilichthys sellaris: Hubbs and Black, 1940:3 (comparison with *P. variatus* group).

Etheostoma (*Etheostoma*) *sellare*: Bailey and Gosline, 1955:16, 39 (vertebrae).—Knapp et al., 1963:455 (rediscovery).—Collette, 1965: 588 (nontuberculate).—Richards, 1966:823–827 (relationships).—Collette and Knapp, 1966:48 (types).

Diagnosis

Distinguished from other darters by the following combination of characters: lateral line straight and complete with 43 to 53 ($\bar{x} = 46.8$) scales; caducous scales lacking; infraorbital and supratemporal canals complete; preoperculomandibular pores ten; branchiostegal membranes slightly conjoined, each with six branchiostegals; snout moderately produced; premaxillary frenum present; vertebrae 39 to 41 ($\bar{x} = 40.1$); first intraneural spine usually between the fourth and fifth neural spines; pyloric cecae two; pelvic fins long, separated by a space equal to ¾ or more of each fin base; anus surrounded by blunt striated lobes, not finger-like villi; preopercular margin entire; anal fin with two spines, the 2nd relatively weak; palatine and vomerine teeth well-developed; back usually crossed by four dark saddles.

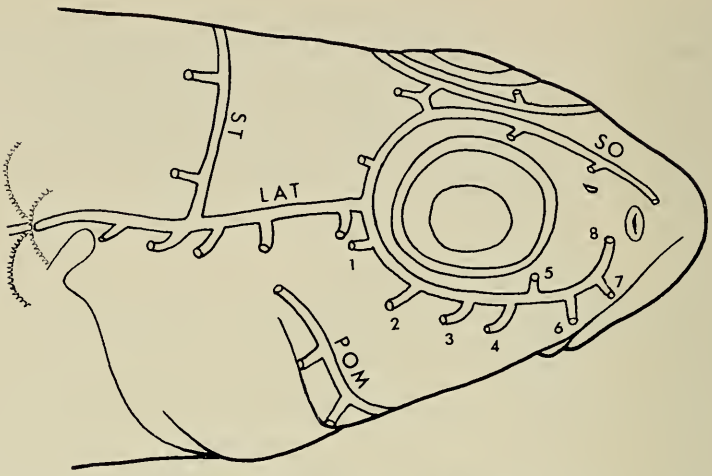

Fig. 2. Cephalic sensory canal system in *Etheosoma sellare*. ST = supratemporal, LAT = lateral, SO = supraorbital. Pores of the infraorbital canal are numbered 1–8. Preoperculomandibular canal (POM) partially shown.

Description

Meristic characters: Scale and fin ray counts are given in Table 1. No differences in counts that could be attributed to sex were found except in the diagonal scale count where there is a slight indication that males may have more scales than females. Precaudal and caudal vertebrae varied from 14 to 16 ($\bar{x} = 14.9$) and 24 to 27 ($\bar{x} = 25.2$) respectively. Total vertebrae varied from 39 to 41 ($\bar{x} = 40.1$); counts of 15 + 25 were found in 51 of 72 specimens.

Squamation: Top of head, nape, breast and prepectoral areas scaleless. Belly naked except, a few weakly ctenoid scales immediately in front of anus in a few specimens. Back, sides, cheeks and opercles with well-developed ctenoid scales. The small ctenoid scales extending onto caudal fin base more extensively developed on upper half of fin. Perhaps there is a correlation between this and another asymmetrical feature of the caudal fin in which the margin of the lower lobe is typically eroded into a broad curve and the upper lobe appears to be slightly longer (no difference between sexes).

Cephalic sensory canals: Cephalic sensory canals (Fig. 2) complete and showed little variation except the infraorbital canal which varied both in position and number of pores between individuals and between left and right sides of the same individual. Observations taken from the right side follow: preoperculomandibular canal (partially illustrated)

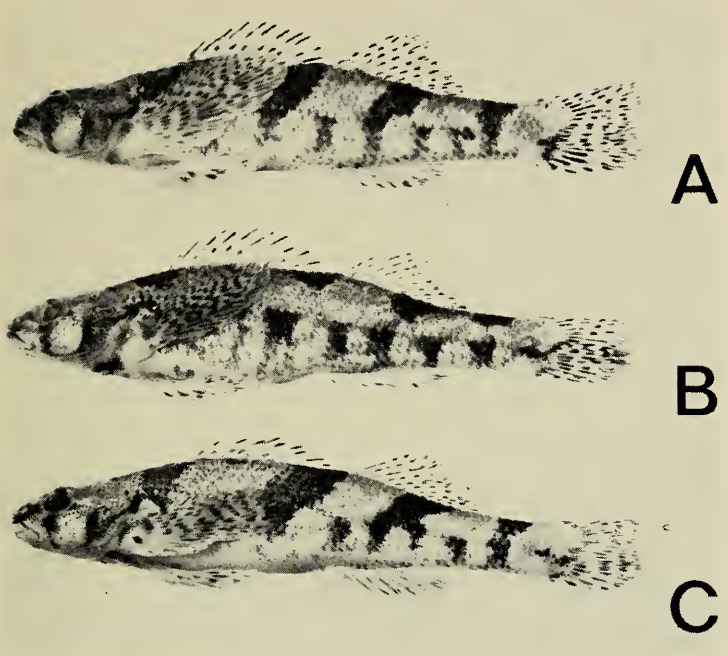

Fig. 3. *Etheostoma sellare*, USNM 212147, Deer Cr. A. Male, 55 mm SL, B. Atypical pattern, female, 63 mm SL. C. Female, 58 mm SL.

with 10 pores (in 72 specimens) and 9 (2): lateral canal with 5 pores (67) or 4 (7); supratemporal canal with a median pore and one lateral pore in all but one specimen which had a second lateral pore; supraorbital canal with coronal, anterior and posterior nasal, interorbital and postorbital pores; infraorbital canal with 8 pores (47), 9 (20) and 10 (7). In individuals with 8 infraorbital pores, 38 had the pattern shown in Fig. 2, 8 had both the 4th and 5th pores directed dorsally and 1 had pores 3, 4 and 5 directed dorsally. Specimens with 9 or 10 infratorbital pores frequently had 3 pores opening toward the upper lip and/or an extra pore directed up toward the eye. Infraorbital canal patterns on right and left sides were similar in 27 specimens and different in 41.

Color in alcohol: *Etheostoma sellare* has a relatively elaborate dark pattern that includes small spots, larger blotches, bars and saddles (Fig. 3). As in many other darters, the largest specimens are usually darkest.

Head more or less extensively stippled with dark brown spots on

opercle, cheek, interorbital area, snout, lips and gular area. Triangular opercular flap behind opercular spine dark brown, melanism extending ventrally along the membrane and along edge of opercle and subopercle varies between individuals. Edge of preopercle outlined in dark brown contrasting with lighter cheek area immediately anterior. A characteristic darkspot at four o'clock position behind eye, a brown, usually vertical subocular bar, an interorbital dark bar that extends onto upper eye and a preocular dark bar angling downward onto upper lip.

Background color of back and sides brownish varying between individuals from brown to light tan. This fades out on lower side so venter appears yellowish. Individual scales or groups of scales having darker pigmentation frequently stand out from surrounding lighter areas. Such darker spots often appear reddish in freshly preserved specimens but are not apparent in life.

Pattern of saddles and blotches on trunk somewhat variable. Most commonly, back crossed by four dark brown saddles which often, but not always, extend ventrally to below lateral line. Widest saddle located between the two dorsal fins, next widest crosses nape in front of first dorsal fin and extends down toward pectoral fin base, a third, slightly narrower saddle lies beneath posterior five or six rays of soft dorsal fin and the narrowest crosses over caudal peduncle. Anterior saddle vertical while remaining three usually slant forward ventrally. Usually three to five dark brown blotches in spaces between saddles just below lateral line. In a second, uncommon pattern, saddles more or less abbreviated to mere dorsal blotches and about seven dark blotches situated below lateral line (Fig. 3B). Intermediacies between the two described patterns occur so that only one, two or three saddles may be developed and frequently a saddle that extends down one side of specimen does not extend down the other. Occasionally a fifth dorsal blotch or saddle is present near middle of first dorsal fin base. The saddles were poorly developed in the juvenile (22 mm SL) taken from Gasheys Run in 1962 and a lateral series of blotches in the form of x's and w's was prominent along trunk. With this color pattern, the Maryland darter juvenile was quite difficult to separate from tessellated dater juveniles taken in the same collection.

Small, black or brown basicaudal spot usually present on termination of lateral line or just below lateral line. Two small yellowish areas near base of caudal fin give caudal fin an asymmetrical pattern; lower area ventral to basicaudal spot and lies primarily anterior to caudal fin base; upper yellowish area somewhat larger and extends onto base of caudal fin rays. The two yellowish areas coincide with development of scale patches on caudal base, described above.

A dark prepectoral bar contrasts with yellowish area located between it and pectoral base; bar usually extends length of pectoral base and sometimes farther ventrad. Below prepectoral bar, one or two discrete brown blotches often extend onto chest just behind opercular membrane.

All fins have dark brown spots developed to a greater or lesser

extent on rays with a few dark chromatophores extending onto adjacent interradial membranes but membranes primarily clear. Dark blotches on rays more or less aligned to give appearance of bands.

First dorsal fin with basal row of brown blotches followed by clear area, then a narrow row of brown blotches followed by clear band and finally a broader band of brown blotches. Tips of the spines clear.

Second dorsal fin has about four or five alternating clear and dark brown bands. Tips of rays clear. About four to six alternating dark brown and yellowish vertical bands on caudal fin; tips of rays clear.

Base of pectoral fin rays with roughly rectangular brown blotch extending across upper eight or ten rays. Below blotch, a light area that can be bright yellow in life; distally about ten alternating yellowish and dark brown bands with yellowish areas somewhat wider.

Pelvic fin typically clear at base, with a few indistinct dark streaks along rays about ¼ distance from base and then two or three alternating dark brown and yellow bands on distal half of fin. Melanism best developed on upper side of pelvic fin rays.

Color in life: The following description is based on field observations made by Raney and Schwartz (18 May 1965), Thomas and Masnik (10 July 1971), and on photographs of live specimens taken by me (1 November 1974).

Scales covered by dark saddles usually brownish (sometimes blackish) with black posterior edges, while scales covered by the lateral dark blotches primarily blackish. Edges of dark saddles, especially posterior edges, appear as greenish flecks. Interspaces between saddles and lateral blotches and light areas of head and nape vary from golden to olivaceous. Lower side and belly usually whitish but some have golden cast. Melanistic stippling and flecking on light colored areas of body varies from slight to moderate but may be heavier on lower sides.

Ray tips of first dorsal, anal, lower pectoral and anterior pelvic fin rays white. Remaining fin ray tips clear. Below clear or milky tips, alternating spots of brown and yellow on rays create appearance of alternating brown and yellow bands. Instead of yellow, two bands near base of anal fin clear as is basal pelvic fin band.

Brightest feature of color pattern is yellow-orange blotch on base of pelvic fin. A second distinctive feature is the golden-orange prepectoral blotch that sometimes surrounds a prepectoral brown bar or may be best developed below the bar. A second golden blotch on lower rear edge of opercle was noted by Michael T. Masnik. Anterior rim of eye golden in life, pupil blackish and iris orange.

Systematic position: Radcliffe and Welsh (1913) placed their new species in the genus *Hadropterus* without comment. Noting the lack of caducous scales, Hubbs and Black (1940) reassigned *Etheostoma sellare* to *Poecilichthys* and discussed its relationships with *P. variatus* group. Bailey and Gosline (1955) envisioned the subgenus *Etheostoma* as including *E. sellare* and 14 other species. The only modification to their interpretation of the subgenus has been the change in status of *E. gutselli*

TABLE 1. Counts of meristic characters in *Etheostoma sellare* (* indicates holotype).

Lateral Line Scales												
43	44	45	46	47	48	49	50	51	52	53	N	$\bar{x}$
2	7	8	12*	21	15	4	4	1	–	1	75	46.8

Least Caudal Peduncle Scales					
16	17	18	19	N	$\bar{x}$
34	30*	10	1	75	16.7

Diagonal Scales					
	6	7	8	9	N	$\bar{x}$
♀	23	8	–	–	31	6.26
♂	21	20	1	1	43	6.58
	44	28	1	1	74	6.54

Dorsal Spines							
7	8	9	10	11	12	N	$\bar{x}$
1	5	32	30	6*	1	75	9.5

Dorsal Soft Rays				
11	12	13	N	$\bar{x}$
17*	51	7	75	11.9

Total Dorsal Rays						
19	20	21	22	23	N	$\bar{x}$
1	10	31	26*	7	75	21.4

Anal Rays				
8	9	10	N	$\bar{x}$
25*	48	2	75	8.7

Total Pectoral Rays						
26	27	28	29	30	N	$\bar{x}$
2	3	48*	10	12	75	28.4

Left Pectoral Rays				
13	14	15	N	$\bar{x}$
4	52*	19	75	14.2

from a species to a subspecies of *E. blennioides* (Miller, 1968), so that the subgenus currently includes 14 species. Based on the presence or absence of breeding tubercles, Collette (1965) recognized three species groups (*E. zonale*, *E. inscriptum*, *E. variatum*). Richards (1966) used differences in dentition, tuberculation, body shape, color pattern and habits to distinguish three somewhat different species groups (*E. blennioides*, *E. thalassinum*, *E. variatum*) and two specialized relatives (*E. bennius* and *E. sellare*). Because of its specialized head shape and naked belly, Tsai (1966) concluded that "*E. sellare* diverged very early from other members in the evolution of the subgenus *Etheostoma*."

The Maryland darter has been placed in the subgenus *Etheostoma* primarily on the basis of vertebral counts, straight and complete lateral line, complete cephalic canals, number of anal spines, branchiostegal membrane connection and presence of dorsal saddles on the body. A comparison of selected characters found in *E. sellare* appears in Table 2. *E. sellare* differs from all other members of the subgenus in shape of snout, type of female urogenital papilla, lack of sexually dimorphic

TABLE 2. Comparison of *E. sellare* with other species in the subgenus *Etheostoma*.

Character	Others in subgenus	*E. sellare*
Shape of snout	blunt and declivitous	moderately produced
Female urogenital papilla	a long tube	a short pad
Coloration	males with bright colors	no bright colors
Branchiostegal juncture	moderately to broadly joined	slightly joined
Saddles	present in *E. variatum* group	present
Fifth infraorbital pore	extended upward on tube in some	upward on tube
Nape squamation	scaled in most	naked
Belly squamation	scaled in most	naked
Cheek squamation	naked in most	scaled
Shape of head viewed from above	not triangular	triangular

coloration and triangular shape of head when viewed from above. Despite breeding colors in male *E. blennius* being restricted to a narrow submarginal orange band and some basal orange markings in the first dorsal fin (a pattern quite similar to that found in the dorsal fin of *E. swannanoa*), I regard the complete lack of such color in *E. sellare* as significant. The Maryland darter also has fewer belly scales than most other members of the subgenus. The belly is completely naked in about 85% of the Maryland darter specimens. A few have scales encroaching toward the midline of the belly immediately in front of the vent and fewer still have one or two scales on the midline in this area but the belly is not really bridged by complete scale rows. Such encroaching scales tend to be smaller than scales on the sides of the body, are often partially embedded and have a reduced number of ctenii. None of the ctenii appear to be enlarged. Some populations of *E. histrio*, *E. rupestre* and *E. blennioides* tend to have a reduction in belly squamation but even in these, the average condition is more scales on the belly than in the Maryland darter. The belly is usually naked only in certain populations of *E. zonale*. The heavily scaled cheek in *E. sellare* can also be found in some populations of *E. zonale* and *E. blennioides* but, aside from a few specimens of *E. rupestre*, the Maryland darter is unique in the subgenus in having a naked nape.

Two additional characters that *E. sellare* shares with at least some members of the subgenus are the upward development of a tube bearing the fifth infraorbital pore and the presence of dorsal saddles. Similar

pore conditions can also be found in four subgenera of *Percina*: *Hadropterus, Ericosma, Alvordius* and *Imostoma.* The presence of saddles is not restricted to the subgenus *Etheostoma* as they are found in *Ammocrypta asprella, Etheostoma trisella* and in *Percina uranidea* and other species of the subgenus *Imostoma.*

Finally, *E. sellare* averages fewer dorsal spines than other species in the subgenus (Table 3).

The above discussion has covered several characters that, within the subgenus *Etheostoma,* are found only in *E. sellare* or are shared by *E. sellare* with one or two other species. Present knowledge indicates that *E. sellare* is a primative darter that, except for lacking caducous scales, might be placed in the genus *Percina.* Within the genus *Etheostoma,* it appears most closely related to the subgenus *Etheostoma* but does not fit there well. It is hoped that additional studies utilizing anatomical, osteological and electrophoretic characters will indicate whether the concept of the genus *Percina* should be expanded to include the Maryland darter, whether a new monotypic subgenus should be erected for it in the genus *Etheostoma* or whether it should be retained in the subgenus *Etheostoma.*

Life History and Ecology

Little is known about the life history, behavior and ecology of the Maryland darter. This is primarily due to the small number of successful collections that have been made and the fact that no collections have been taken just prior to or during spawning. The high and turbid water conditions that typically prevail on lower Deer Creek during the spring have made collecting and observation of the darter very difficult.

Adults in CU 48607 (Deer Creek, 18 May 1965) are clearly post-spawning specimens with gonads and urogenital papillae in regressed states. Several specimens were checked for ripeness in the field by Raney with negative results. Ovaries in the adult female in USNM 212146 (Gasheys Run, 25 April 1965) were also regressed so spawning may have occurred in the early or middle part of April. April water temperatures in Gasheys Run average several degrees higher than those in Deer Creek. Gonads and urogenital papillae appear well-developed in adult specimens taken in Deer Creek, November 10, 1965 (USNM 212147). The right ovary from a specimen (64.2 mm SL) collected in November contained 407 eggs with an average diameter of one mm. Egg counts from gravid females are needed to estimate the number of eggs that actually mature.

Urogenital papillae and the lobes surrounding the anus are illustrated in Fig. 4. In both sexes, the anus is surrounded by irregularly shaped, flattish lobes that are quite different from the fingerlike villi found in *Etheostoma vitreum.*

As the breeding season approaches, the female urogenital papilla

TABLE 3. Dorsal spine counts in the subgenus *Etheostoma* (modified from Tsai, 1966, Richards, 1966 and Miller, 1968).

Species	Number of dorsal spines										
	7	8	9	10	11	12	13	14	15	N	$\bar{x}$
E. sellare	1	5	32	30	6	1	–	–	–	75	9.5
E. histrio	–	–	71	222	48	–	–	–	–	328	9.9
E. inscriptum	–	7	129	494	67	3	–	–	–	700	9.9
E. thalassinum	–	1	44	174	37	–	–	–	–	256	10.0
E. zonale lynceum	–	1	7	78	33	1	–	–	–	120	10.2
E. zonale zonale	–	–	11	200	666	100	3	–	–	980	10.9
E. rupestre rupestre	–	–	–	10	36	7	1	–	–	54	10.9
E. blennius	–	–	–	–	16	20	3	–	–	39	11.7
E. rupestre cahabanum	–	–	–	3	33	80	9	–	–	125	11.8
E. tetrazonum	–	–	–	1	5	20	3	–	–	29	11.9
E. swannanoa	–	–	–	1	29	80	23	–	–	133	11.9
E. osburni	–	–	–	1	1	21	19	–	–	42	12.4
E. variatum	–	–	–	–	–	24	18	–	–	42	12.4
E. euzonum	–	–	–	–	–	5	6	–	–	11	12.5
E. kanawhae	–	–	–	–	1	14	28	2	–	45	12.7
E. blennioides gutselli	–	–	–	–	1	35	37	15	–	88	12.8
E. blennioides pholidotum	–	–	–	–	11	192	557	120	3	883	12.9
E. blennioides blennioides	–	–	–	–	4	143	640	163	2	952	13.0
E. blennioides newmani	–	–	–	–	1	94	852	614	56	1,618*	13.4

* Includes one specimen with 16 dorsal spines not shown in table.

Fig. 4. Ventrolateral view of urogenital papillae in *Etheostoma sellare*. A. Male, B. Female.

develops as a swollen white pad that nearly reaches the first anal spine. The short urogenital papilla of the male, appearing like the tip of a bullet, shows little seasonal variation in size and shape and is often obscured by the overhanging anal flaps. The anal flaps connecting to either side of the base of the male urogenital papilla were described by Hubbs and Black (1940). No breeding tubercles have been found in the Maryland darter.

Examination of length frequencies of 72 specimens (Fig. 5) of the Maryland darter taken in Deer Creek (31 in May 1965, 35 in Nov. 1965, 4 in Aug. 1970 and 2 in July 1971) indicates the presence of three year classes. Lumping length data from different collection dates is usually not an acceptable practice, and the data in Fig. 5 probably presents an erroneous picture of the number of individuals in an age group or year class at a given time. Unfortunately, no single collection was large enough to demonstrate a clear picture of the number of age groups or year classes in the population at a given time and I believe that the lumped data has clarified this aspect. This assumption is valid only if there is little variation in the growth rate in different years. A cursory examination of scales seemed to verify that the three apparent peaks represent age groups 0, I and II. Scales from the 70 mm SL specimen showed three annuli and possibly a fourth. The average SL of age group 0 males and females was 53.9 mm and 47.3 mm respectively but in combining the remaining age groups, males averaged 60.4 mm SL and females 58.8 mm SL. It appears that some actual size differences between sexes in older specimens may exist because the seven largest specimens were males. The 21 mm juvenile in CU 43491

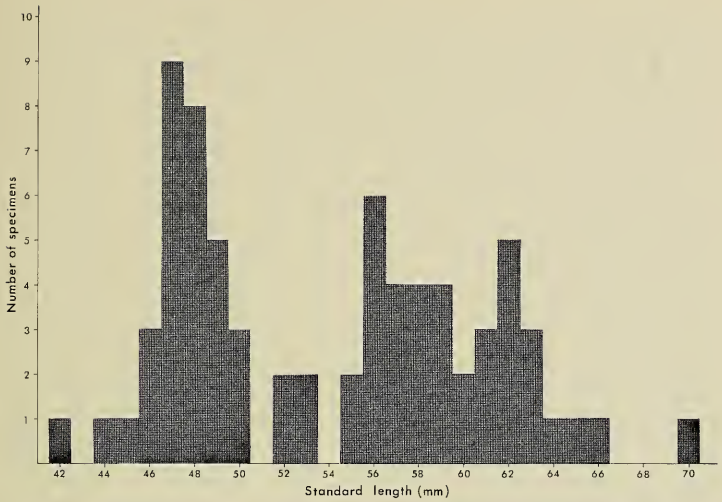

FIG. 5. Length frequency distribution of 72 specimens of *Etheostoma sellare* from Deer Creek.

(Gasheys Run, 10 June 1962) was undoubtedly a young-of-the-year fish.

Radiographs taken to provide vertebral counts of the Maryland darter also revealed some information about food habits. Of the 35 specimens taken on Nov. 10, 1965, 28 had from one to approximately eleven ($\bar{x} = 6.2$) snails in their digestive tracts. No snails could be seen in the other seven specimens and digestive tracts were removed from five of these. The contents were as follows: specimen no. 2, parts of three different caddis fly larvae (Hydropsychidae, *Hydropsyche* sp.); spec. no. 5, one larval *Hydropsyche* sp., one mayfly head (Heptageniidae), four snails (Hydrobiidae, probably *Clappia virginica*); spec. no. 6, one larval *Hydropsyche* sp., two stone fly nymphs (Perlidae); spec. no. 10, two larval *Hydropsyche* sp.; spec. no. 20, two complete and parts of two other larval *Hydropsyche* sp. The digestive tract was removed from one specimen whose radiograph showed snails and was found to contain seven snails that are close to *Clappia virginica* (Hydrobiidae) and remnants of two larvae of *Hydropsyche* sp. No snails were visible in the radiographs from 32 specimens collected during April and May but a single snail was present in one of five specimens taken 29 August 1970.

According to Joseph Rosewater (pers. comm.), *Clappia virginica* is found on vegetation and rocks and on silty substrates in rivers and in the mouths of smaller tributaries. It appears that snails and caddis fly larvae are a major constituent of the fall diet of the Maryland darter in

Deer Creek. Although snails have been found in the diets of other species of darters (Page, 1974; Stiles, 1972), they have usually been in trace amounts. Recently snails have been found to be an important food item in darters of the subgenus *Imostoma* and perhaps the major food item of *Percina tanasi*, the snail darter (Etnier, 1976).

All Maryland darter specimens except the two from Gasheys Run and the two type-specimens have come from the immediate vicinity of the large riffle on Deer Creek just below Stafford Road bridge. On 23 October 1974, this riffle was found to be about 25 meters wide across the crest. Gurly flowmeter readings taken in swift water near the foot of the riffle at heights of 5.1, 20.3 and 45.7 cm above the bottom were 29, 84.8 and 79 cm/sec. respectively. The maximum depth of the riffle, 61 cm, was at the point where the flowmeter readings were taken. The bottom is primarily rubble and rocks near the crest of the riffle with silt and gravel becoming more abundant toward the sides and foot. Rooted aquatic plants are moderately abundant on rocks in the riffle area. Plant samples taken on 10 November 1965 were riverweed, *Podostemum ceratophyllum* along with smaller amounts of curly pondweed, *Potamogeton crispus*.

A U.S. Geological Survey water stage recorder gauge is located on Deer Creek 15 m upstream from the U.S. Highway 1 bridge, 1.6 km north of Kalmia, Maryland. The gauge site is 44 m above sea level and about 18.1 km above the site of the Maryland darter. Average daily discharges, in cubic meters per seconds (cms) during the unusually wet period from October 1972 to September 1973 were: October, 3.6; November, 8.4; December, 10.9; January, 8.7; February, 9.9; March, 7.4; April, 12.2; May, 9.2; June, 7.9; July, 5.4; August, 3.8; and September, 3.4. The average daily discharge during the above period, 7.5 cms, contrasts with the average over the six previous years of 5.6 cms. That the Maryland darter has to contend with rather severe fluctuations in water level is evidenced by the following readings at Kalmia: from 3.6 cms on 13 November to 47.5 cms on 14 November 1972; from 15.4 cms on 7 December to 32 cms on 9 December 1972; from 7.1 cms on 31 March to 28.6 cms on 2 April 1973; and from 9.5 cms on 27 May to 35.1 cms on 28 May 1973. Obviously the flows at the Stafford Road crossing are in excess of those upstream at Kalmia.

Edward C. Raney (field notes, 18 May 1965) indicated that most of the Maryland darters were taken on the south side of the riffle within 5 m of shore, that a few were taken along the north side of the riffle where the current was not too swift and that none were taken in the center of the riffle. Apparently the water level at the Deer Creek site was higher on this date than on subsequent dates when the darter was collected. On 23 October 1974, a specimen was taken at the foot of the riffle where the depth was 61 cm and on 1 November 1974, one specimen was taken near the south shore in shallow water and one specimen was taken near the head of the riffle a little north of midstream, also in shallow water. Collette and Knapp encountered water conditions

so low on 10 November 1965, that the crest of the riffle was only 9 to 15 m wide. The deepest part of the riffle was carrying enough water for seining and the Maryland darters were primarily taken in the swiftest area of the current, a chute no more than 6.1 m in width. At this time, several juveniles were taken up to 30 m below the riffle area and up to 60 to 90 m upstream from the bridge.

Other fishes most commonly found associated with *E. sellare* in the Deer Creek riffle are *Anguilla rostrata* (Lesueur), *Nocomis micropogon* (Cope), *Rhinichthys atratalus* (Hermann), *R. cataractae* (Valenciennes) and *E. olmstedi* (Storer). Of these, the longnose dace is probably the most abundant. *E. olmstedi* is not commonly taken with *E. sellare* and prefers the quieter currents at the edges of the riffle.

Distribution

To date, the Maryland darter has been reported from only three Harford County, Maryland sites: Swan Creek, Gasheys Run and Deer Creek (Fig. 1).

No additional specimens have been collected from Swan Creek since the type-collection in 1912. To quote Radcliffe and Welsh (1913), "The examples of the new species herein described were seined in Swan Creek, near Havre de Grace, Maryland, in water 6 inches deep, on a long, stony riffle, where the bottom was comparatively free from bowlders and the current so swift that one would not have expected to find fishes of any kind." The above description of the type-locality is vague and as the lower reaches of Swan Creek are heavily silted today, there is little possibility of identifying the riffle in question.

The precise location where the juvenile specimen was taken on Gasheys Run in 1962 is unknown as it was collected unnoticed among many tessellated darter juveniles. It was taken within a distance of 0.8 km upstream or downstream from the Oakington Road crossing. The 1965 female specimen was taken from a small riffle located approximately 0.8 km upstream from the Oakington Road crossing. Records of the Maryland darter from Deer Creek are only from the area immediately adjacent to the Stafford Road crossing of the stream.

The two confirmed Maryland darter sites in Gasheys Run and Deer Creek are located on the lower reaches of those streams. In Deer Creek, it appears to be the first major riffle area above tidewater while in Gasheys Run, it is somewhat further upstream. A considerable amount of collecting in Gasheys Run and a moderate amount of collecting in Deer Creek indicates that, despite the presence of seemingly good habitat further upstream and the lack of any appreciable physical barrier, the Maryland darter does not move up these streams much above base level. Perhaps, like *Etheostoma histrio* (see Tsai, 1968), *E. sellare* is restricted to swift riffles of the Coastal Plain. If so, its range in the lower Susquehanna River could have been markedly reduced when the submergence of coastal areas resulted in the formation of Chesapeake

Bay. A further constriction of range may have occurred with completion of Conowingo Dam in 1928 and other impoundments further upstream toward Harrisburg. The mouths of streams immediately above Conowingo Dam are inundated and comparable sites on many streams such as Swan Creek below the dam are rather heavily silted and more or less polluted. If this reasoning is correct the Deer Creek riffle site may be the only habitat for the Maryland darter remaining in the lower Susquehanna drainage.

Unlike Swan Creek, the lower reaches of Gasheys Run flow through woodlands and except for immediately above its mouth, are relatively unsilted. Gasheys Run is about 8 km in length and, at normal flow, most riffles are only 1 to 3 m in width. The riffles are primarily composed of gravel and currents are slower than in Deer Creek as evidenced by the replacement of *Rhinichthys cataractae* with *R. atratalus* and by the abundant presence of *Etheostoma olmstedi*. During droughts, Gasheys Run barely maintains a flow. It is probable that the lack of suitable habitat prevents *E. sellare* from becoming permanently established in Gasheys Run and that only stragglers from Deer Creek are periodically found there. Such stragglers may occasionally spawn in Gasheys Run and so account for the juvenile taken in 1962 but it is possible that the juvenile was also a straggler. It is only about 21 kms from the mouth of Deer Creek to the mouth of Gasheys Run and during periods of peak discharge, the influence of freshwater from Deer Creek may be detected along the west bank of the Susquehanna River down to its mouth (pers. comm., Kenneth Unruh). With the periodic high water levels in Deer Creek mentioned previously and with Conowingo Dam blocking upstream movement, conditions are certainly favorable for the movement of Maryland darters downstream. Darters do survive in the upper Bay as appreciable numbers of *Etheostoma olmstedi* are found along the shore above the mouth of Swan Creek. Gasheys Run is the first significant tributary entering the upper Bay on the western shore below the mouth of the Susquehanna River.

One alternative to a Deer Creek origin of stragglers reaching Gasheys Run would be for the Maryland darter to live in the Susquehanna River below Conowingo Dam. This would not appear likely as severe fluctuations in the amount of water released from Conowingo Dam occur almost daily. When the dam is generating electrical power, the river below resembles a giant raceway. Much of the substrate is bedrock and unconsolidated materials such as rubble and gravel have almost been flushed out. Protected areas tend to fill with silt. Little darter collecting has been attempted in this difficult and seemingly unfavorable habitat so it cannot be entirely ruled out as a possibility.

Status

If the Deer Creek riffle site supports the only permanent population, the outlook for the continued survival of this species is grim. Its

apparently chosen habitat near the mouth of the creek is vulnerable to disturbances, man-made or natural. Limnological studies (pers. comm., Dr. John Foerster, WAPORA, Inc., Washington, D.C.) have indicated appreciable amounts of pollution there in recent years from agricultural and other sources. Samples of algal growths that were common along the margins of Deer Creek at Stafford Road crossing on 21 August 1974 primarily consisted of the blue green genera *Microcoleus* and *Oscillatoria*. These are probable indicators of pollution. The sewage treatment plant at Stewartstown remains a threat because of its possible malfunction, not to mention the poorly understood, long-term effects of chloramines introduced there.

The Maryland darter is protected by both federal and state regulations and recently the Fish and Wildlife Service, USDI, appointed a "recovery team" (Charles Frisbie, Maryland Department of Natural Resources, John Sheridan, U.S. Fish and Wildlife Service and Leslie Knapp) to draft a "recovery plan" in an attempt to promote the survival of this unique fish. Further clarification of the range and ecological requirements of *E. sellare* is prerequisite to such a plan and a survey is in progress. When such information is available, it is hoped that some measure of permanent protection can be accorded to the Maryland darter.

Material

All collections of the Maryland darter known to me are listed below. Collections not examined in this study are indicated by an asterisk following the catalog number. The following abbreviations have been used: National Museum of Natural History (USNM); Cornell University (CU); Tulane University (TU); Museum of Zoology, University of Michigan (UMMZ); Virginia Polytechnic Institute (VPI); University of Florida, Gainesville (UF). USNM 74346 (♂, 39 mm SL), holotype, Swan Cr. near Havre de Grace, Harford Co., Md., 2 May 1912, Lewis Radcliffe and William W. Welsh. USNM 74347 (♂, 39), paratype, same data as holotype. CU 43491 (1, 21), Gasheys Run at Oakington Rd. crossing, 0.9 mi E jct Oakington Rd. and Hw 22 in Aberdeen, Harford Co., Md., 10 June 1962, L. W. Knapp, W. J. Richards, Robert Victor Miller and N. R. Foster. USNM 212146 (♀, 48), same locality as CU 43491, 25 April 1965, L. W. Knapp, B. B. Collette and D. M. Cohen. CU 48607 (9♂, 7♀, 44-62), Deer Cr. at Stafford Rd., 1.2 mi above mouth at Susquehanna R and 2.3 mi SE Darlington, Harford Co., Md., 18 May 1965, E. C. Raney and F. J. Schwartz. CU 48607* (2), same data, cleared and stained. CU 49496 (9♂, 6♀, 46–63), same locality and collectors as CU 48607, 30 May 1965. USNM 212147 (18♂, 16♀, 42–70), same locality as CU 48607, 10 Nov. 1965, L. W. Knapp, Collette and H. A. Fehlmann. UF 20808 (♂, 58), same data as USNM 212147. TU 64249* (2, 45, 61), removed from CU 49496. CU 99006 (2♂, 52, 61), same locality as CU 48607, 29 Aug. 1970, D. C.

Thomas and M. Masnik. VPI 2468 (♀, 58; ♂, 60), removed from CU 99006. VPI 2651 (♂, 53), same locality as CU 48607, 10 July 1971, D. L. Thomas, Masnik and J. Wong. UMMZ 191647* (1, 62), same data as VPI 2651.

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